

CLAIMS

1. A semiconductor optoelectronic waveguide comprising:

5 a second semiconductor clad layer arranged on each of one main surface and the other main surface of a semiconductor core layer having electro-optical effects;

a pn junction layer arranged on the second semiconductor clad layer laminated on one main surface
10 of the semiconductor core layer wherein the side of the second semiconductor clad layer is a p-type and the side opposed to the second semiconductor clad layer is an n-type; and

a third semiconductor clad layer arranged on the pn
15 junction layer and the second semiconductor clad layer laminated on the other main surface of the semiconductor core layer and functioning as an n-type electrode layer.

2. The semiconductor optoelectronic waveguide
20 according to claim 1, wherein

a first semiconductor clad layer is arranged between each of one main surface and the other main surface of the semiconductor core layer and the second semiconductor clad layer,

25 a band gap of the first semiconductor clad layer is greater than that of the semiconductor core layer, and each band gap of the second semiconductor clad layer

and the third semiconductor clad layer is greater than the band gap of the first semiconductor clad layer.

3 The semiconductor optoelectronic waveguide
5 according to claim 1 or 2, wherein the pn junction layer is established for the thickness of each layer and the impurity concentration in such a way that under an operating state of the semiconductor optoelectronic waveguide, the p layer is depleted in a whole range while the n layer
10 is at least partially depleted.

4. The semiconductor optoelectronic waveguide according to claim 1, 2 or 3, wherein the impurity concentration is $1 \times 10^{17} \text{ cm}^{-3}$ or greater for the p layer
15 of the pn junction layer and $5 \times 10^{17} \text{ cm}^{-3}$ or greater for the n layer.

5. The semiconductor optoelectronic waveguide according to any of claims 1 to 4, wherein an impurity
20 forming a deep level is doped on the n layer of the pn junction layer, in addition to an n-type impurity.

6. The semiconductor optoelectronic waveguide according to any of claims 1 to 5, wherein a band gap energy
25 of the n layer of the pn junction layer is smaller than that of the p-layer of the pn junction layer.

7. The semiconductor optoelectronic waveguide according to claim 5 or 6, wherein the impurity having a deep level and doped on the n-layer of the pn junction layer is Fe.

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8. A semiconductor optoelectronic waveguide comprising;

a semiconductor core layer having effective electro-optical effects;

10 a first and a second semiconductor clad layers which vertically hold the semiconductor core layer and whose band gap is greater than that of the semiconductor core layer;

a third and a fourth semiconductor clad layers which
15 vertically hold the first and the second semiconductor clad layers and contain an n-type dopant;

a fifth semiconductor layer having the first and the third semiconductor clad layers on the substrate side, which is arranged between the first semiconductor clad
20 layer and the third semiconductor clad layer, containing a p-type dopant and whose band gap is greater than that of the semiconductor core layer;

at least one electrical isolation region formed by implanting ions into the fourth semiconductor clad layer
25 to improve the quality of materials; and

electrodes individually provided at a major region other than the electrical isolation region of the fourth

semiconductor clad layer and at the third semiconductor clad layer,

wherein voltage is applied to the semiconductor core layer.

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9. The semiconductor optoelectronic waveguide according to claim 8, wherein

the implanted ion species is an atom which forms an acceptor or a deep donor/acceptor pair level inside the
10 fourth semiconductor clad layer.

10. The semiconductor optoelectronic waveguide according to claim 8 or 9, wherein the fourth semiconductor clad layer is provided with three or more electrical
15 isolation regions.

11. The semiconductor optoelectronic waveguide according to claim 8, 9 or 10, wherein an electrode is provided on the fourth semiconductor clad layer which is
20 opposed to a major region of the fourth semiconductor clad layer across the electrical isolation region, and connected to an electrode of the third semiconductor clad layer.

12. A semiconductor optoelectronic waveguide
25 comprising;

a semiconductor core layer having electro-optical effects;

a first and a second semiconductor clad layers which vertically hold the semiconductor core layer and whose band gap is greater than that of the semiconductor core layer;

5 a third semiconductor clad layer containing an n-type dopant which is arranged under the first semiconductor clad layer;

a fourth semiconductor clad layer which is arranged on the second semiconductor clad layer;

10 a fifth semiconductor layer in which the third semiconductor clad layer and the first semiconductor clad layer are arranged on the substrate side and a p-type dopant is contained between the second semiconductor clad layer and the fourth semiconductor clad layer and whose band
15 gap is greater than that of the semiconductor core layer;

a major region of an n-type modulation waveguide formed inside a part of the fourth clad layer;

an isolation region adjacent to the major region, having a p-type electrical conductivity and in contact
20 with an electrode common to the major region; and

another electrode provided on the third semiconductor clad layer,

wherein voltage is applied to the semiconductor core layer via both of the above-described electrodes.

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13. The semiconductor optical modulation waveguide according to claim 12, wherein a part of the major region

of the n-type modulator waveguide inside the fourth clad layer is given a region having a p-type electrical conductivity and the region having the p-type electrical conductivity is provided with an electrode electrically
5 common to the n-type major region.

14. The semiconductor optoelectronic waveguide according to claim 12 or 13, wherein a pair of electrodes are provided on the fourth clad layer on both outer sides
10 of the major region of the n-type modulator waveguide and each of the electrodes is connected to an electrode of the third semiconductor clad layer.